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OPTICAL AND D. C. MAGNETIC PROPERTIES OF SPACE RELATED MATERIALS

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MAGNETIC SUSCEPTIBILITY OF SPECIMEN FROM THE ZHAMANSHIN METEORIATE CRATER

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Magnetic susceptibility measurements of two tektites from the Zhamanshin Structure, a shallow crater near the town of Irgiz in Kazakhstan. The indicated tektites were called irghizites (P. V. Florensky, 1975), following the custom of naming groups of tektites for the place where they are found. This is the first major tektite discovery in about 25 years and it has already proven to be highly instructive (J. A. O'Keefe, 1978). The crater where the irghizites were found is a shallow despression about five kilometers in diameter. The crater is filled, according to Florensky (1975) with from 100 to 150 meters of lake sediments on top of broken rocks.

Various hypotheses are expressed regarding the formation of the Zhamanshin meteorite crater and the slag and glasses it contains. The Zhamanshin Structure is either due to: human activity, volcano reuption, or to the results of the fall of a gigantic meteorite. The literature reveals that a great deal of slag was left during the smelting of bronze in ancient times. But most of the metallurgical slags are partly recrystallized and contain a great deal of copper.

The refused rocks of the Zhamanshin landmark sharply differ from the metallurical stages and there are no ore manifestations in the area; therefore, their anthropogenic origin is improbable. G. A. Kostik and B. V. Piliya (1973) and I. I. Kuzentson (1974) consider the glasses of the Zhamanshin landmark to be products of a volcanic eruption. However, the absence of volcanism of similar age and character on the Turansk plate and in the Urals, and the absence of a volcanic structure that usually forms during the eruption of acid lavas, as well as features of the composition of the glasses, speak against the eruption volcano hypothesis. In 1969, (Kirykhin, Florenskiy and Sobolev), the hypothesis of the impact origin of the Zhamanshin structure was stated. Either the tektites made the Zhamanshin crater or the Zhamanshin crater made the tektites. A second hypothesis was that a large block of tektite glass could have come from out of space, dug the crater and disintegrated to form the irghizites. A third hypothesis was that a large meteorite could have landed at the site, forming the crater and at the same time transforming some of the local rock into tektite glass; perhaps, by boiling away some of its more volatile constituents.

The irghizites are small black objects averaging about 1/2 a gram in mass. Some are warty striate objects, while others are warty twisted objects that resemble the Aorelloul and Darwin glass tektites in shape. Their chemical composition, according to Kurt Fredrikson, of the Smithsonian Institution, is uniform from specimen to specimen. It is unlike that of any local rocks and is very similar to that of the tektites found in Java craters. The resemblance to the Javanites extends to the trace elements, as reported by Yu. F. Pogrebnyak in the U.S.S.R. and by William D. Ehmann, Joh A. Philpotts, C. S. Annell, John W. Morgan and other investigators in the United States. Like all other tektites, the irghizites are homogenous glasses lacking even small crystals.

Therefore, the glasses and slags of the Zhamanshin landmark are similar in composition to other glasses and slags of known impact meteorite structure. Their similarity of composition make it possible to attribute the formation of the Zhamanshin landmark to the impactite theory. A group of scientists

(Florenskiy, Kiryukhin et. al., 1969; Kostik, Piliya, 1973; Kuznetsov et. al., 1974) made an extensive chemical analysis of several Zhamanshinites using the x-ray microanalyzer of the Institute of Geology and Geophysics of the Siberian Department of the Academy of Science of the U.S.S.R. (Table 1). The most apparent observation was that the Zhamanzhinites composition was quite different from the magnetic rocks and their similarity to the tektites and impacites was a common occurance. The chemical composition of all the Zhamanshinites structures correspond to impactites, thus forming a fundamental series of formation with common aspects wihch are important in principle, and which indicate their relationship to tektites.

The content of Potassium (K) and Sodium (Na) in magnetic rock layers between 12-15%. Yet, whereas in the Zhamanshinites slag and tektites potassium (K) and sodium (Na) is from 2-3 times less. The composition of calcium in the Zhamanshinites fluctuates within large limits, from 0.6 to 11.0%. Therefore, one might conclude that the Zhanamshinites formed during the transformation of limestone to clay! Many impactites tektites, and all the Zhamanshinites found in the Zhamanshine crater are over-saturated with Al_2O_3 and SiO_2. It was also established that the Zhamanshinites contained an unusual extremely low content of Nickel (Ni); less than 0.03%, while tektites percentage is around 0.1%. The Zhamanshinites cobalt and chromium concentration is 0.004% and 0.007% prespectively, while tektites contain approximately 0.013% and 0.03% of cobalt and chromium respectively. Therefore, judging by the elevated content of Ni and Co, it is not impossible that meteorite materials are present. One would also conclude that the Zhamanshinites may be placed among the tektites because they are similar to philippinites or to the javanites according tothe opinion of O'Keefe (1976).

Susceptibility Measurements

The principal measurement investigated during the Summer of 1978 was the determination of the increase in the magnetic susceptibility of the Zhamanshin landmark specimen as the temperature was lowered from room temperature of 77^{o}K. The measurements were made on a quartz helical Cahn Electrobalance.

The results from table #1 represent the susceptibility, Curie Constant, and magnetization for the specimen taken from the Zhamanshin structure.

Table 1

Sample Number	(Mg) Mass	General Appearance	$X_1 10^{-6}$	$C10^{-3}$	$X_0 10^{-6}$	(alpha)	
983-1	8.85	striated	7.4115	1.7035	9.2362	0.01960	midsection
983-2	2.29	striated	2.5458	2.5386	9.2516	0.00697	light in color
983-4	6.48	striated	6.3512	3.6805	1.1761	0.01-69	midsection
983-5	10.78	striated	1.0039	2.3083	9.5452	0.001156	light in color
974-1	10.325	black	1.7910	2.0680	8.0434	0.002283	
981-2	9.493	black	2.1909	1.9703	7.7170	0.002914	

Theory

The magnetic susceptibility "X" of a substance is defined as the ratio of the acquired magnetization "M" of the substance to the applied magnetic field "H". A substance if said to be diamagnetic if it is repelled by the magnetic field, thus having a negative susceptibility, para-magnetic if it is slightly attracted by the external magnetic field, which in turn produces a positive susceptibility. Para magnetism is associated with the amount of alignment the permanent magnetic moments of the atoms can attain in the applied magnetic field. Diamagnetism is the results of the orbital motion of the electrons, which give rise to an induced magnetic field within the atoms opposing the external applied magnetic field.

Methods of Measurements and Procedure

A magnetic field study was made on each sample at room temperature, using an electro-magnetic to produce the magnetic field. Each sample was suspended separately into a glass tube and the magnetic susceptibility was calculated using the Cohn Balance. This technique has been explained in the literature (Thorpe, Sullivan, Hambright, 1971). After the completion of the field study for each sample, a suitable operation magnetic field was selected to calculate the susceptibility as a function of temperature. The sample is suspended in such a manner that it is a distance of two or three millimeters from Au-Co Thermocouple. The temperature dependent of the thermo-couple is measured with a digital voltmeter. The sample tube is evacuated and carefully filled to within a few millimeters below atmospheric pressure with helium gas, which serves as the heat transfer medium. The sample tube is then placed in a metal dewar. The temperature of the sample is controlled by gradually pouring small quantities of liquid nitrogen into the metal dewar.

In order to record data, the temperature and the Cohn Balance must be stable. Then several measurements of susceptibility were made and an average value plotted against 1/T on regular graph paper.

The plot of susceptibility Ag versus 1/T generates the graph which has a slope of "C" (Curie Constant) and the intercept as the sum of the temperature, independent terms. These results may also be reported as the Curie-Weiss Equation used in the form $1/\chi_m = T/C + t/C$ where Xm is the molar susceptibility corrected for diamagnetism.

The plot of susceptibility "X_g" versus 1/H of the data in terms of the equation $X_g = X_{diam} + X_{para} + X_{tip}) + \alpha/H$, generates a graph with a slop called α(alpha), and the intercept at 1/H = 0 is the sum of the field independent susceptibilities. If the sample contains a relatively large amount of ferro-magnetic materials of impurities then the alpha (α) is positive. If the sample has no ferro-magnetic material, then α(alpha) is zero.

A ferro magnetic material has a spontaneous magnetic moment - a magnetic moment even in zero applied magnetic field, a spontaneous moment suggests that electron spins and magnetic moments are arranged in a regular manner. Consider a paramagnet with a concentration of "N" ions of spin "S". Given an internal interaction tends to line up the magnetic moments parallel to each other. This is true for ferro-magnetic materials. Now, such an interaction is called the exchange field or molecular field. The orienting effect of the exchange field is opposed by thermal agitation, and at elevated temperatures the spin order is destroyed. If we treat the exchange field as equivalent to the magnetic field H_E, then H_E is proportional to the magnetization "M". The magnetization M(H,T) is defined as a magnetic moment per unit volume. Thus we can write $H_E = \lambda M$ where λ is a constant, independent of the temperature. The constant "H" is the applied magnetic field at a specific temperature "T".

If "X" represent the magnetic susceptibility, then $M = S(H + H_E)$. The susceptibility is given by the Curie Law, $X = C/T$, where "C" is the Curie Constant. combining the two equations, $MT = C(H + \lambda M)$ and $X = M/H = C/T\text{-}C\lambda$, the susceptibility has a singularity at $T = C\lambda$. Now if "M" equal to zero then $X = C/T\text{-}T_c$, where $T_c = C\lambda$. Thus we have the Curie-Weiss Law. From this we use the average value calculated for the Curie Constant, and calculate the percentage of FeO.

$X = \frac{C}{T-T_c}$ where $T_c = C\lambda$

U^2 = # of Bohr magnaton

also $C = \frac{NU^2B^2}{3K}$

$U^2 = 4."S"\ (S + 1)$

$U^2 = 4(2)(2 + 1)$

$U^2 = (8)(3) = 24$

then

$N = \frac{3KC}{U^2B^2}$ where $U^2 = 24$

$= \frac{4.14 \times 10^{-16} \times 2.5 \times 10^{-3}}{24 \times .81 \times 10^{-40}}$

$B = .927 \times 10^{-20}$
Bohr magnaton

$B^2 = .81 \times 10^{-40}$

$= .532 \times 10^{21}$

also $N = \frac{6.023 \times 10^{23}}{55.85} \Big| \frac{\text{concentration}}{100}$

$\text{Conc} = \frac{(N)(55.85)(100)}{6.023 \times 10^{23}}$

$= \frac{(55.85)(.532) \times 10^{21}(100)}{6.023 \times 10^{23}}$

= 4.93% Fe

Since the Fe is tied up in the form of FeO $\quad FeO = \frac{55.85 + 16\ (\text{Conc of Fe})}{55.85}$

FeO = 6.34%

In concluding, most of the previous research shows that a plot of Xg versus 1/H for tektites produces a curve with a zero slope. Therefore, the results generated by the plotting of susceptibility versus 1/H for the Zhamamshin and Irghizites produced curves with a slope of zero.

The calculations of the percentage of FeO from the Curie-Weiss Law produced a value of 6.34% which is highly significant when compared to a value of 6.30% FeO as determined by Florensky and others (1969) from Chemical Analysis (table 2).

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